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WIND EROSION PREDICTIONS WITH THE WIND EROSION EQUATION (WEQ) USING DIFFERENT CLIMATIC FACTORS

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ABSTRACT

Little information is available on the performance of the Wind Erosion Equation (WEQ) for estimating wind erosion under differing climatic conditions. The objective of this study was to assess the fitting of measured and WEQ-estimated wind erosion with different climatic *C* factors. Results showed that WEQ underestimated the annual wind erosion by 45 per cent when loaded with the historic *C*, obtained with climatic data records between 1981 and 1990. The monthly averaged *C* factor (monthly *C*, $n = 12$) underestimated the erosion by 29 per cent, the *C* factors of each one of the six studied years (annual *C*, $n = 6$) underestimated the erosion by 19 per cent, and the *C* factors of each one of the evaluated months (monthly *C*, $n = 72$) overestimated the erosion by 31 per cent. Precipitation explained most of *C* factors variability. *C* factors corresponding to high precipitation periods predicted low erosion amounts in no-till (NT) and conventional tillage (CT). C factors corresponding to low precipitation periods calculated high erosion rates in CT (143 t ha^{-1} y^{-1}) and low in NT (2·4 t ha^{-1} y^{-1}). The historical *C* factor predicted no erosion in NT and 7·1 t ha^{-1} y^{-1} in CT. These results indicated that the WEQ should be used with variable *C* factors in order to assess different climatic scenarios of the semiarid Argentina. Copyright © 2007 John Wiley & Sons, Ltd.

KEY WORDS: wind erosion; WEQ; semiarid regions; climatic factor; Argentina

INTRODUCTION

The Wind Erosion Equation (WEQ, Woodruff and Siddoway, 1965) is an empirical model designed to estimate mean annual potential wind erosion occurring in agricultural fields. The climatic condition, represented by the climatic factor *C*, is one of the most important variables to be loaded in the model to make suitable wind erosion predictions.

Few attempts were made to compare the predictions obtained with WEQ with field observations. Results obtained to date suggest that WEQ does not predict field observations appropriately because the model does not simulate adequately the effect of climate (Fryrear *et al*., 2001). Recently, van Pelt and Zobeck (2004) manipulated the soil erodibility index and the climatic factor in order to obtain an agreement between estimated and observed erosion. They concluded that increasing the annual input *C* value to nearly four times the published value, a close agreement between predicted and observed erosion was found.

The information about WEQ performance throughout several years of differing climatic conditions is scarce. Furthermore, little is known about the influence of different climatic *C* factors on wind erosion estimates.

Most of the necessary inputs for operating WEQ in any region can be extracted from charts, but parameters needed for climate simulation must be calculated specifically for each location. This set of parameters allows WEQ to simulate the wind erosion climatic erosivity, defined by Skidmore (1986) as a measure of the climatic tendency to produce conditions conductive to wind erosion. Climatic erosivity in WEQ is basically represented by the *C* factor,

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which expresses the relation between mean annual wind speed and soil surface wetness:

$$C = \frac{386\,\overline{U}_{\mathrm{z}}^{3}}{(P-E)^{2}} \tag{1}$$

In this equation $\overline{U}_{\mathrm{z}}$ represents mean annual wind speed meters per second at 9·2 m height and *P-E* is the annual precipitation effectiveness index (Thorntwaite, 1931), calculated using monthly precipitation and temperature. Climatic factor has only been related to intensity and frequency of dust storms in the region were it was developed, by Chepil *et al*. (1962). Later on, Woodruff and Armbrust (1968) recommended the use of monthly *C* factors, which integrated monthly wind speeds to improve erosion estimates particularly within a year. The lack of an adequate number of years with meteorological data is a major restriction for analysing the influence of the climatic factor on erosion estimates. Wind erosion estimates should improve when using *C* factors specifically calculated for each measurement period. However, to our knowledge, the effectiveness of monthly climatic factors has not been evaluated yet.

The objective of this study was to assess the correlation between measured and wind erosion estimated with WEQ, using *C* factors corresponding to different periods of time. We also tested the wind erosion predicted with WEQ for two representative soils of the semiarid Argentina submitted to different tillage practices.

MATERIALS AND METHODS

Wind erosion measurements were carried out in 1 ha square eroding field of the semiarid Pampas of Argentina, located at latitude 36° 34' S, longitude 64° 16' W and 210 m above sea level. The soil at the study site was a fine sandy-loam Entic Haplustoll, containing 1·84 per cent organic matter, 12·2 per cent clay, 19·7 per cent slime and 66·26 per cent sand. Climate (1977–2001) at the study site is characterised by a mean annual air temperature of 15·5°C, a mean annual relative humidity of 70 per cent, a mean annual precipitation of 764·2 mm and a mean annual evaporation of 1513·8 mm (Vergara and Casagrande, 2002). Prevailing wind directions are N–S and mean annual wind speed is 11·1 km h^{-1} at 10 m height. From August to December, mean wind speed varies between 10 and 16 km h^{-1}, with wind gusts higher than 60 km h^{-1} (Casagrande and Vergara, 1996).

The eroding field was ploughed with a disker in order to maintain a bare and flat surface.

Wind erosion in the eroding field was measured with BSNE samplers (Fryrear, 1986) located in four sampling points at the middle of each field side. Three BSNE samplers were placed at 0·135, 0·5 and 1·5 m height in each sampling point.

Vertical mass flux in each sampling point was calculated using the equation

$$\frac{f(z)}{f_0} = (1 + z/\sigma)^{-2}$$

developed by Zingg (1953) and modified by Stout and Zobeck (1996), which represents the mass of eroded material as a function of height, being *f*(*z*) the mass flux at height *z*, f_0 the mass flux at the soil surface ($z=0$) and σ a scale height. Total mass flux (*Q*) at each sampler cluster for each erosive event was calculated by integrating the equation between 0 and 1·5 m.

The net soil loss for each event was estimated by subtracting the incoming material to the field from the material living the field, considering the prevailing wind direction during the event.

Wind erosion was sampled in the eroding field in 183 storm events occurred on years 1995, 1996 and 2002–2005. All these storms completed 8239 h, ranging each storm between 1 and 120 h.

Wind speed and wind direction were measured at 1-min intervals with an automatic weather station placed at the centre of the eroding field.

An Excel spreadsheet version (8·07) of the WEQ (Sporcic and Nelson, 2002) was used to estimate wind erosion. This version requires monthly wind intensity-frequency distribution data as well as a description of the relative magnitude of winds coming from different directions. Using mean hourly wind speed data obtained at the study site

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during 1994–2001, monthly wind speed distribution was determined applying the Weibull distribution function using 1 m s^{-1} intervals (Wagner *et al.*, 1992). Previously, wind speeds were adjusted to a 10 m reference height according to:

$$u_2 = u_1\left(\frac{\bar{z}_2}{z_1}\right)^{1/7}$$

where u_1 and u_2 represents wind speed at heights z_1 and z_2, respectively (Elliot, 1979). An accumulated distribution function was used ($F_1(u)$), in which calm periods are eliminated:

$$F_1(u) = \frac{(F(u) - F_0)}{(1 - F_0)} = 1 - \exp^{(u/c)k}$$

where: F_0 is the frequency of calm periods or wind speed, c is scale parameter (m s^{-1}), k is dispersion parameter (dimensionless). Rewriting the equation and taking the logarithm a lineal form of the equation is obtained; applying the least squares method k and c parameters for each month can be, therefore, calculated (Skidmore and Tatarko, 1990).

The averaged monthly erosive wind energy was calculated for wind speeds between 5 and 20 m s^{-1} using the Weibull parameters according to Bondy *et al*. (1980). Using mean wind speed by direction and directions frequency summaries published by the Argentine Air Force for the 1981–1990 period, erosive wind prevailing direction was determined monthly for each of the main eight quadrants. Magnitude of each wind erosion force vector r_j was calculated according to the following equation:

$$r_j = \sum_{i}^{n} \overline{U}_i^3 f_i$$

where $\overline{U}_i^3$ is the mean wind speed within the ith speed group and f_i is the percentage of total observations that occur in the jth direction within the ith group. The relative magnitude of winds coming from different directions was obtained on a monthly basis, analysing parallel and perpendicular forces to each direction. The predominant wind erosion direction resulted from the ratio between parallel and perpendicular forces calculated for each wind direction. Erosive forces parallel and perpendicular to an imaginary line representing a wind direction were calculated as follows:

$$F \parallel = \sum_{j=0}^{15} r_j |\cos(j \times 22 \cdot 5 - \theta)|$$

$$F \perp = \sum_{j=0}^{15} r_j |\sin(\mathrm{j} \times 22 \cdot 5 - \theta)|$$

where θ is the angle indicating the imaginary line orientation.

The relation between parallel and perpendicular forces to each direction is symbolised by R. The maximum value of R (R_m) indicates the prevailing wind erosion direction and the preponderance of this prevailing force. As R_m increases, so does the preponderance of the prevailing wind erosion direction (Skidmore, 1965).

Climatic factor (C) was calculated based on methodology proposed by Lyles (1983), in the following way:

$$C = 386\left(\frac{\overline{U}_z^3}{\sum_{i=1}^{12} 10(P - E)_i}\right)$$

in which $\overline{U}_z$ is the mean annual wind speed at 10 m high, expressed in m s^{-1}, 'I' represents each month and[Q3], Q3

$$10\,(P - E) = \left[\frac{P/2 \cdot 54}{1 \cdot 8T + 32}\right]^{10/9}$$
$$P \geq 1 \cdot 27\mathrm{cm};\ T \leq -1 \cdot 7\,^{\circ}\mathrm{C}$$

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where P is the mean monthly precipitation and T it is the mean monthly temperature.

Based on climatic data for the study site the following C values were calculated: (a) a C factor for the 1981–1990 period (historical C, $n = 1$), (b) a C factor for each one of the 6 years, using annual average climatic data (annual C, $n = 6$), (c) a C factor for each month of each one of the 6 years (monthly C, $n = 72$), (d) an averaged monthly C factor for the 1981–1990 period (averaged monthly C, $n = 12$), (e) a C factor representing a rainy year based on the 1981–1990 period (low C, $n = 1$), and (f) a C factor for dry years (1981–1990; high C, $n = 1$). For assessing the variability of annual precipitation, mean annual temperature and mean annual wind speed, a coefficient of variation (CV) was calculated as the standard deviation divided by the mean value.

The climatic data used for the calculation of annual, monthly, averaged monthly, high, low and historical C are shown in Tables I and II. A unique 12·5 km h^{-1} wind speed value was used for the calculation of all the C values, excepting for the monthly C, where wind data for each individual month was considered (Woodruff and Armbrust, 1968). For computing high and low C values, minimum and maximum mean monthly precipitation values were used, respectively.

Wind erosion was estimated using the WEQ Excel spreadsheet version for a 4 year crop rotation typically developed in the Argentinean semiarid Pampas (Table III). Predictions were made for an Entic Haplustoll ($I = 193$ t ha^{-1} y^{-1}) and two tillage systems: conventional tillage (CT) and no-till (NT). Three different C values were used for these predictions: the historical C (11·75), the high C (168·06) and low C (1·72). The field length (L) was 500 m, the ratio between field length and width was 1 and the predominant tillage direction was N–S. The simulation for the NT conditions accounted for standing residues. The soil roughness was reduced to zero (10^{-7}) and soil cover was considered minimum (weeds, winter, <6 weeks). Results for each simulation were compared with the matching field observation by simple regression analysis.

Table I. Mean wind speed, mean temperature and mean precipitation data used for the calculation of the annual, the monthly C and the averaged monthly C

Year	January	February	March	April	May	June	July	August	September	October	November	December
Mean wind speed (m sec^{-1}, at 10 m height)												
1995	14·2	13·6	12·5	9·7	8·6	10·7	11·2	12·3	13·8	15·1	13·0	15·5
1996	13·1	13·8	10·2	10·4	9·3	8·1	10·4	12·3	13·3	12·8	13·2	11·5
2002	8·1	7·4	8·7	7·3	7·2	7·9	8·4	9·4	9·8	10·8	9·3	9·7
2003	8·6	8·4	6·2	8·8	8·3	8·7	10·2	12·0	13·7	15·7	13·1	13·8
2004	10·7	10·3	12·1	6·7	8·9	8·8	10·8	9·1	6·9	10·3	6·8	9·2
2005	9·6	7·3	10·9	9·4	7·0	4·5	10·1	11·1	13·6	11·5	14·1	14·9
Average	12·8	13·6	11·8	10·4	10·1	8·7	11·4	13·2	14·9	14·8	14·2	13·7
Mean temperature (°C)												
1995	22·5	21·4	19·3	15·4	12·1	8·4	7·2	8·9	12·8	15·6	20·2	25·2
1996	22·6	20·9	20·2	14·9	23·0	7·0	7·3	12·1	12·2	16·3	20·2	20·4
2002	21·7	20·7	18·7	14·3	11·8	6·3	8·3	9·5	12·5	15·9	18·7	20·9
2003	24·3	22·8	21·6	14·7	11·8	9·2	7·6	8·3	13·5	18·0	19·6	21·7
2004	24·8	20·6	21·4	15·4	9·6	9·3	8·6	9·6	13·4	15·1	18·1	20·9
2005	22·5	23·5	19·5	14·7	10·9	8·4	8·5	9·7	11·9	15·3	21·0	21·6
Average	23·7	22·5	19·0	15·0	10·7	7·6	7·2	9·4	11·8	15·8	19·4	22·7
Mean precipitation (mm)												
1995	77·8	22·7	61·0	53·5	3·0	4·1	0·0	6·2	13·5	115·0	43·7	29·0
1996	119·2	135·1	88·8	33·1	19·7	9·5	15·5	44·0	14·8	63·0	117·9	388·0
2002	176·4	19·6	70·5	68·5	45·0	16·4	20·0	93·0	41·0	73·0	40·4	84·2
2003	50·7	13·0	55·5	54·0	13·3	0·7	2·8	14·4	4·8	53·7	64·6	50·2
2004	40·8	64·8	83·8	81·6	7·0	2·7	79·3	33·6	8·0	89·6	85·9	130·8
2005	35·9	27·2	82·8	0·2	29·3	20·9	6·8	13·6	58·4	47·9	24·0	61·5
Average	94·0	64·0	95·6	69·0	37·3	9·2	32·0	28·6	53·0	57·0	96·5	90·0

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Table II. Precipitation and temperature data used for the calculation of the historical-, the high- and the low *C* (1981–1990)

		January	February	March	April	May	June	July	August	September	October	November	December
Precipitation (mm)	Mean	94·0	64·0	95·6	69·0	37·3	9·2	32·0	28·6	53·0	57·0	96·5	90·0
	Maximum mean	201·9	112·0	141·2	163·0	77·3	21·3	175·9	85·1	132·1	173·7	159·5	228·9
	Minimum mean	27·7	6·5	36·0	1·0	4·5	0·0	0·0	0·0	8·2	10·0	17·6	32·5
Mean temperature (°C)		23·7	22·5	19·0	15·0	10·7	7·6	7·2	9·4	11·8	15·8	19·4	22·7

Table III. Rotation loaded on WEQ

Operation date	Crop name	Operation name	Flat Res. (%)	Yield adjustment (%)
01/01/2005	—	Start rotation	—	—
15/02/2005	Sunflower	Over summer loss N	50	—
15/03/2005	Sunflower	Disk, offset, heavy N	90	—
30/04/2005	Sunflower	Disk, offset, heavy N	100	—
15/06/2005	Wheat, winter, yield low	Drill or air seeder, DD opener N	100	—
01/07/2005	Wheat, winter, early 015	Grow	100	—
25/12/2005	Wheat, winter, yield low	Harvest	50	−10
15/02/2006	Wheat, winter, yield low	Disk, offset, heavy F	90	—
18/02/2006	Oats, spring	Drill or Air seeder, DD opener N	100	—
03/03/2006	Oat, spring 15	Grow	100	—
30/03/2006	Oat, spring 45	Grow	100	—
01/09/2006	Oats, spring	(Grazing period)	100	—
15/09/2006	Oats, spring	Disk, offset, heavy F	90	—
25/10/2006	Sunflower	Planter, DD opener, w/fluted coulters F	100	—
15/11/2006	Sunflower 15	Grow	100	—
25/02/2007	Sunflower	Harvest	50	50
26/02/2007	Sunflower	Disk, offset, heavy N	90	—
15/03/2007	Sunflower	Disk, offset, heavy N	90	—
30/04/2007	Sunflower	Disk, offset, heavy N	100	—
15/06/2007	Wheat, winter, yield low	Drill or air seeder, DD opener N	100	—
30/06/2007	Wheat, winter, early 015	Grow	100	—
25/12/2007	Wheat, winter, yield low	Harvest	50	−10
15/02/2008	Wheat, winter, yield low	Disk, offset, heavy F	100	—
18/02/2008	Oats, spring	Drill or air seeder, DD opener N	100	—
04/03/2008	Oat, spring 15	Grow	100	—
30/03/2008	Oat, spring 45	Grow	100	—
01/09/2008	Oats, spring	(Grazing period)	100	—
15/09/2008	Oats, spring	Disk, offset, heavy F	100	—
25/10/2008	Sunflower	Planter, DD opener, w/fluted coulters F	100	—
15/11/2008	Sunflower 15	Grow	100	—
31/12/2008	Sunflower 60	Grow	100	—
15/01/2009	Sunflower 75	Grow	100	—
30/01/2009	Sunflower 90	Grow	100	—
12/02/2009	Sunflower	Harvest	100	50
13/02/2009	Sunflower	End rotation	50	—

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RESULTS AND DISCUSSION

WEQ loaded with the historical C factor (11·75) estimated 10·2 t $ha^{-1} y^{-1}$ of soil loss, while the measured wind erosion was 18·59 t $ha^{-1} y^{-1}$. The model underestimated the measured erosion by 45 per cent. The tendency to underestimation of WEQ is in agreement with results of van Pelt and Zobeck (2004) and Buschiazzo and Zobeck (2006). These authors attributed these trends to unmeasured changes in the soil surface conditions induced by rain (van Pelt and Zobeck, 2004), or to errors in the calculations of the horizontal mass flux from field data (Buschiazzo and Zobeck, 2006).

The adjustment between measured and predicted wind erosion using the historical C factor was not significant for none of the following periods of time shorter than 1 year: each individual wind erosion event ($n = 183$), each month of each one of the six studied years ($n = 72$) and the months of all the studied years together ($n = 12$).

When the annual C factors were considered ($n = 6$) a significant correlation between predicted and calculated erosion existed (Figure 1a). Annual C values ranged from 3·4 (1995) to 30·3 (2002), and erosion estimates varied

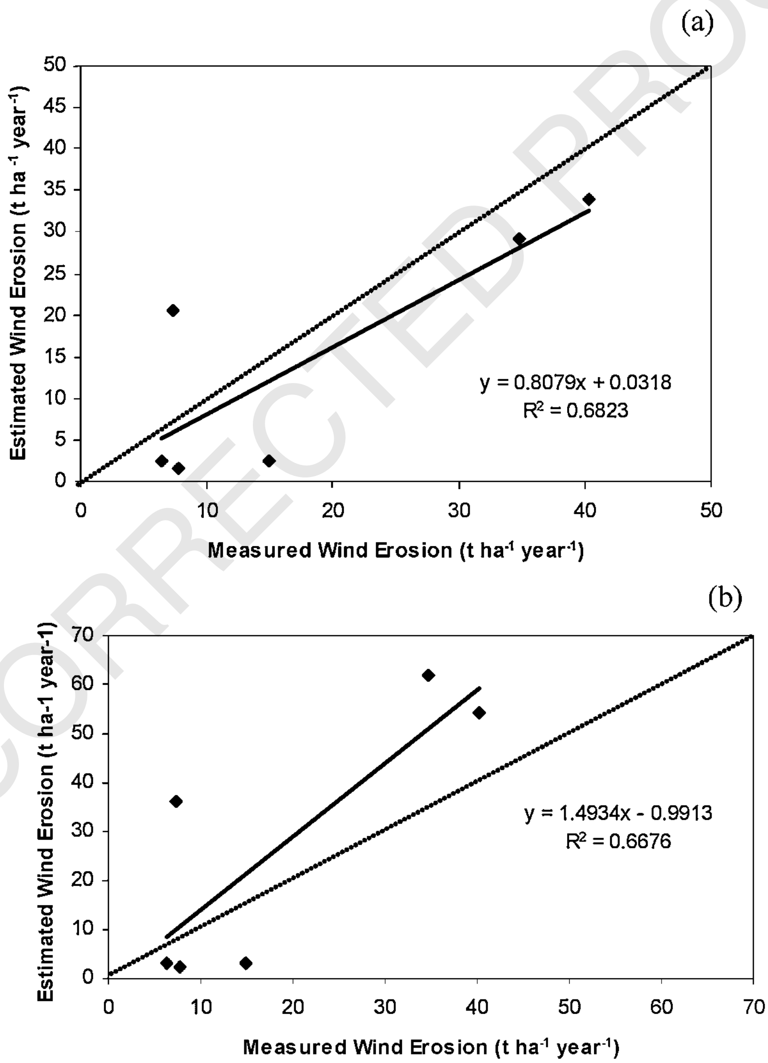

Figure 1. Measured versus estimated wind erosion using (a) annual C and (b) monthly C factors.

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Table IV. Measured and estimated erosion using annual *C* factors

Year	Annual C factor	Measured erosion ($t\,ha^{-1}$)	Predicted erosion ($t\,ha^{-1}$)	Prediction (%)
1995	30·29	40·28	34	84
1996	4·30	14·98	2·4	16
2002	3·39	7·82	1·6	20
2003	26·67	34·74	29·1	84
2004	4·40	6·39	2·5	39
2005	20·35	7·32	20·70	280
Average	14·9	18·59	15·05	87·2

between 1·6 and 34 $t\,ha^{-1}\,y^{-1}$ (Table IV). The averaged estimated annual erosion was 15·05 $t\,ha^{-1}\,y^{-1}$, a value 36 per cent higher than that predicted by the historical *C*.

Using the averaged monthly *C* factors, WEQ estimated 13·26 $t\,ha^{-1}\,y^{-1}$, underestimating the measured erosion (18·59 $t\,ha^{-1}\,y^{-1}$) by 28·7 per cent. This increment in the estimated erosion in relation to data obtained with the historical *C* factor, indicated that the climatic variations were better represented by the averaged monthly *C* factors than by the annual *C* factor. This can be attributed to the fact that the monthly *C* represents 12 different *C* values within a year, accounting for some of the intra-annual climatic variability not considered by an averaged annual *C*. This increased, therefore, the erosion estimates of the monthly *C* against the historical *C*.

Using monthly *C* factors the correlation between the estimated and the measured erosion was also significant (Figure 1b). Erosion estimates ranged from 2·2 $t\,ha^{-1}\,y^{-1}$ (2002) to 54·1 $t\,ha^{-1}\,y^{-1}$ (1995), and the monthly *C* values (Table V) varied between 1·5 (June 1996) and 105·3 (October 2003). Wind erosion was overestimated by 30·6 per cent using the averaged *C* factors. This overestimation was found to occur mainly in years with high climatic erosivity conditions (1995, 2003 and 2005). During these years precipitations were lower than 430 mm, and the mean wind speeds were relatively high in the spring (Table I). The combination of these climatic conditions might explain the overestimations of wind erosion by WEQ, since the *C* factor is known to be very sensible to low precipitations (Skidmore, 1986).

In order to assess the relative effect of different climatic variables on the inter-annual climatic variability, the variability of rain, temperature and wind velocity was analysed for 1977–2005 period. Results indicated that rain was more variable (CV = 30·54), followed by the wind velocity (CV = 10·36) and temperature (CV = 2·76). These results indicated that rain variability may represent better the inter-annual climatic variation and, therefore,

Table V. Monthly *C* values

Month	Year					
	1995	1996	2002	2003	2004	2005
January	54·67	6·31	2·70	16·96	7·37	17·64
February	47·73	7·46	2·12	16·22	6·62	7·84
March	36·76	2·98	3·38	6·35	10·62	26·46
April	17·30	3·21	2·01	18·50	1·79	16·95
May	11·91	2·27	1·91	15·51	4·30	7·06
June	23·27	1·47	2·58	17·72	4·12	1·87
July	26·71	3·21	3·10	28·66	7·63	20·57
August	35·66	5·28	4·34	46·24	4·48	27·39
September	50·43	6·68	4·89	69·84	2·00	50·62
October	65·47	5·95	6·55	105·34	6·62	30·28
November	41·40	6·49	4·17	60·67	1·89	56·46
December	70·50	4·22	4·70	71·78	4·67	66·03
Average	40·15	4·63	3·54	39·48	5·17	27·43

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Table VI. Mean annual wind erosion of an Entic Haplustoll under conventional tillage (CT) and no-till (NT) for three different climatic conditions (*C* factors)

Climatic conditions	CT	NT
	$t\ ha^{-1}\ y^{-1}$	
High precipitation period ($C = 1{\cdot}72$)	0·8	0
Mean climatic conditions ($C = 11{\cdot}75$)	7·1	0
Low precipitation period ($C = 168{\cdot}06$)	143·3	2·4

the climatic conditions for wind erosion occurrence. Rain determines the erosion rates by regulating plant growth, soil wetness, soil surface roughness and crusting processes, being one of the main climatic variables considered in wind erosion studies. Several authors considered that precipitation strongly affects the *C* factor value (Skidmore, 1986), and others demonstrated that precipitation and dust storms are positively correlated (Hagen and Woodruff, 1973).

Different *C* factors calculated with minimum, mean and high precipitation values can allow testing the behaviour of WEQ under different climatic conditions. Results presented in Table VI show that WEQ predictions using an historical *C* (11·75) reached 7·1 $t\ ha^{-1}\ y^{-1}$ for the Entic Haplustoll in CT, while no erosion was recorded in NT. Under CT conditions the erosion rate was 11 per cent lower than the tolerable value (8 $t\ ha^{-1}\ y^{-1}$, Smith and Stamey, 1964; Woodruff and Armbrust, 1968[Q4]). Q4

The WEQ loaded with the high *C* factor (168·06), corresponding to years with low precipitations, estimated 143·3 $t\ ha^{-1}\ y^{-1}$ for CT (1791 per cent higher than the tolerable value) and 2·4 $t\ ha^{-1}\ y^{-1}$ for NT (70 per cent lower than the tolerable value). The erosion amount predicted was lower than that reported by Aimar (2002), who measured 270 $t\ ha^{-1}\ y^{-1}$ for soil with coarser textures than the Haplustoll studied here, during a dry and windy period.

WEQ estimates were 2 to 20 times greater when using *C* values corresponding to low precipitation periods than when using an historical *C*. Similar findings have been reported by van Pelt and Zobeck (2004), who found an annual erosion rate variation of 21 times under similar soil ($I = 193$) and climate conditions ($C = 10$). Using a low *C* factor (1·72), corresponding to years with high precipitation, the estimated erosion was 0·8 $t\ ha^{-1}\ y^{-1}$ for CT and no erosion was estimated for NT.

CONCLUSIONS

Using the historical *C* factor, corresponding to the climatic data of the period 1981–1990, WEQ underestimated annual erosion rate by 45 per cent for a bare Entic Haplustoll of Argentina. Erosion estimates for periods shorter than 1 year did not fit well with the measured erosion when the historical *C* factor was used.

WEQ loaded with the averaged *C* factors for each month of the 6 years period (monthly *C*, $n = 12$) underestimated the erosion by 29 per cent. When the *C* factors of each one of the studied years (annual *C*, $n = 6$) were used, WEQ underestimated the erosion by 19 per cent, and with *C* factors corresponding to each one of the evaluated months (monthly *C*, $n = 72$) an overestimation of 30·6 per cent was calculated. Precipitation variability was associated with the variability of the *C* factors. WEQ erosion estimates for a 4 year wheat–oats–sunflower rotation were highly variable when using *C* factors of different climatic conditions (rain amounts) given in the period 1981–1990. When using *C* factors corresponding to high precipitation periods, WEQ predicted low wind erosion amounts in both tillage systems (between 0 and 0·8 $t\ ha^{-1}\ y^{-1}$). If *C* values corresponding to low precipitation periods were used, WEQ gave very high wind erosion amounts in CT (143 $t\ ha^{-1}\ y^{-1}$) but still low in NT (2·4 $t\ ha^{-1}\ y^{-1}$). With the historical *C*, WEQ detected no erosion in NT and 7·1 $t\ ha^{-1}\ y^{-1}$ in CT. These results indicated that the historic *C* factor can hardly represent the high climatic variability of semiarid regions to predict wind erosion. We concluded that WEQ should be used with variable *C* factors in order to assess wind erosion under different climatic scenarios of the semiarid Argentina.

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